IN THE CLAIMS

1. (Original) A method of terrain mapping and/or obstacle detection for aircraft, comprising:

(a) transmitting a non-scanning beam that illuminates the terrain and/or obstacles;

(b) receiving a Doppler shifted signal that is Doppler frequency shifted by an amount dependent on an angle between a line of flight of the aircraft and scatterers that reflect the transmitted beam;

(c) determining the angle from the Doppler frequency;

(d) determining the range of at least some of said scatterers; and

(e) determining the azimuth and elevation of the scatterers.

2. (Original) A method according to claim 1 wherein determining the azimuth and angle comprises:

determining one of azimuth and elevation of the scatterers by direction finding; and

calculating the other of the azimuth and elevation from the angle and determined azimuth and elevation.

3. (Original) A method according to claim 2 wherein determining the azimuth or elevation comprises determining using an off-axis monopulse azimuth estimation scheme.

4. (Withdrawn) A method according to claim 2 wherein determining the azimuth or elevation comprises determining using interferometry.

5. (Original) A method according to claim 1 and including;

displaying a three dimensional map in which cells defined by different values of azimuth, elevation and range containing a backscatter signal are located.

6. (Original) A method according to claim 1 and including:

displaying a three dimensional terrain map in which the relative backscatter intensity of cells defined by different values of azimuth, elevation and range is expressed.

7. (Previously Presented) A method according to claim 1 and including:

generating and displaying skyline contours based on cells defined by different values of azimuth, elevation and range.

8. (Original) A method according to claim 7 and including displaying backscatterers which are at lower elevation and lower range than the skyline.

9. (Original) A method according to claim 7 and including displaying at least one safety circle superimposed on the skyline display.

10. (Original) A method according to claim 9 and including displaying a plurality of safety circles for a plurality of ranges.

11. (Original) A method according to claim 1 and including providing aural or visual warnings when the aircraft is moving in an unsafe direction.

12. (Withdrawn) A method according to claim 1 wherein determining the angle comprises:

providing a plurality of signals, each representing the strength of the Doppler shifted signal from a scatterer in one of a plurality of adjacent, overlapping, frequency ranges; and

determining the frequency of the Doppler frequency signal by interpolation based on the signal strengths.

13. (Currently Amended) A method according to claim 1 wherein determining the angle comprises:

performing spectral analysis, in which at least some signals from scatterers ~~falls~~ fall within one of a plurality of Doppler filters, said Doppler filter containing said signal determining the Doppler shift of the signal, from which the angle is calculated.

14. (Withdrawn) A method according to claim 1 wherein determining the angle includes:

repeating at least (a) and (b) and optionally (c) a plurality of times; and

averaging the determined Doppler shifted frequencies or angles determined in each repeat.

15. (Withdrawn) A method according to claim 14 wherein only a limited range of angles about the line of flight is determined using a limited range of Doppler frequencies.

16. (Previously Presented) A method according to claim 1 wherein a backscatter Doppler signal from a terrain cell or object, located on the opposite side of the aircraft's line of flight from a range cell or object of interest and falls within the same range cell and same Doppler filter is suppressed by a null, common to both sum and difference patterns of an antenna receiving said Doppler shifted signal.

17. (Original) A method according to claim 16 wherein an error resulting from a residue of the suppressed backscatter is averaged out by summing or averaging multiple measurements, taken at a single frequency or at multiple frequencies.

18. (Original) A method according to claim 17 wherein said multiple measurements are performed at different frequencies and wherein pulses of the transmitted radiation at different frequencies are transmitted seriatim, in an interleaved manner.

19. (Original) A method according to claim 18 wherein determination of the angle by spectral analysis of the reflections for the different frequencies are performed in parallel, utilizing said interleaved pulses.

20. (Original) A method according to claim 1 and including resolution of elevation ambiguity comprising:

determination of skyline contours, possibly containing tall, discrete obstacles, from said elevation, range and azimuth, said skyline contours including an upper contour and a lower contour, only one of which is real;

if the area between the contours is substantially empty of measured scatterers, then the lower contour is chosen as the real contour; and

if the area between the contours contains a substantial number of scatterers, then the upper contour is chosen as the real contour.

21. (Original) A method according to claim 20 wherein if parts of the contours have scatterers between them and other parts do not, each such part is treated separately according to said acts of determination of skyline contours.

22. (Original) A method according to claim 20 and comprising displaying only the chosen contour on a visual display.

23. (Previously Presented) A method according to claim 20 wherein, if the determination of angle, azimuth and range results in an elevation ambiguity of a surface contour, wire or tall discrete obstacle indication, the method includes resolving the ambiguity by a pull-up or push-down maneuver of the aircraft.

24. (Original) A method according to claim 23 wherein,

if the maneuver is a pull-up maneuver that causes the upper and lower contours or wire or tall discrete obstacle indication to move apart from each other, then the lower contour or indication is determined to be the correct contour or indication and vice-versa; and

if the maneuver is a push-down maneuver that causes the upper and lower contours or indications to move apart from each other, then the upper contour or indication is determined to be the correct contour or indication, and vice-versa.

25. (Withdrawn and Currently Amended) A method according to claim 1 wherein, if the determination of angle, azimuth and range results in an elevation or azimuth ambiguity of a surface contour or wire or tall discrete obstacle indication, the method includes:

resolving the ambiguity by pointing a null in the elevation or azimuth pattern of an antenna to either or both of the indications of a scatterer;

sensing a difference in the object's backscattered power; and

choosing the direction of the null which caused a decrease of received power as the ~~actual~~ correct direction.

26. (Previously Presented) A method according to claim 1 wherein, ground reflections are separated from actual object backscatter, based on a_difference in Doppler shift between the object's backscatter and its ground reflections.

27. (Original) A method according to claim 26 in which the differences in Doppler shift are quantized to form a plurality of ranges of Doppler shift defining a plurality of ranges of the angle, wherein ground reflections detected in a same range of distances as the actual object are separated from the object, based on their falling in different ranges of Doppler shift.

28. (Original) A method according to claim 1 in which the differences in Doppler shift are quantized to form a plurality of ranges of Doppler shift defining a plurality of ranges of the angle and the effect of ground reflections is detected in a same range of Doppler shifts and distances as the actual object, the effect of the ground reflections is reduced by pointing a null in an antenna pattern towards the general direction of the reflection sources at an elevation angle lower than that indicated by the combined directly reflected and ground reflected signals.

29 – 30. (Canceled)

31. (Withdrawn) A method according to claim 1, and including:

deducing of the presence of a wire based on detection of a regular spacing between point obstacles, indicating that these obstacles may be pylons, carrying wires.

32. (Withdrawn) A method according to claim 1, and including:

detecting suspended wires, based on normal impingement of said beam; and

determining the presence of the wire by:

irradiating the wire with radiation at two orthogonal polarizations; and

determining the presence of the wire from a ratio of received backscatter intensities in the two polarizations.

33. (Withdrawn) A method according to claim 32 and including determining the orientation of wire by rotating the polarization and finding a pair of orthogonal polarizations for which the ratio of intensities of received backscatters is above a certain threshold, the wire being parallel to the orientation which produced ~~a~~ the stronger backscatter.

34. (Previously Presented) A method according to claim 1 and including determining the horizontal orientation of wires at low elevation, the method comprising:

determining the azimuth of wire's reflection point; and

estimating the horizontal orientation as the normal to the determined azimuth.

35. (Withdrawn and Currently Amended) A method according to claim ~~32,~~ 33 and including determining the orientation of a wire in the vertical plane, provided a point of normal incidence

is at low elevation, and where the slant angle of the wire is parallel to the polarization that produced ~~a stronger~~ the strongest backscatter

36.(Withdrawn and Currently Amended) A method according to claim 32, including determining the wire's orientation in space, where a point of normal incidence need not be limited to low elevation, said determining comprising:

a) determine the azimuth and elevation of line of sight to a detected point of normal incidence;

b) determining a plane normal to the line of sight at the point of normal incidence; and

c) determining a line in the plane, parallel to the polarization which produced ~~a stronger~~ the strongest backscatter ~~polarization~~, said line estimating the direction of the wire.

37. (Original) A method according to claim 13, wherein results from a number of adjacent Doppler filters, corresponding to backscatter from at least one sector away from the aircraft's line of flight, are summed or averaged.

38. (Original) A method according to claim 37 wherein results from sectors relatively closer to the line of flight are either not summed or averaged or are summed or averaged to a lesser extent than those farther from the line of flight.

39. (Currently Amended) A method according to claim 1, and including:

detecting suspended wires, based on normal impingement of said beam; and

discriminating wires from other objects when the reflecting point on the wire appears to be at constant azimuth as the aircraft advances, as long as the wire and the line of flight are in substantially a same elevation plane.

40. (Original) A method according to claim 39, where discriminating wires from other objects is further based on a discontinuity of backscatter in the elevation plane, when no backscatter comes from elevations between the wire's reflection point and the ground.

41. (Previously Presented) A method of terrain mapping and/or obstacle detection for aircraft, comprising:

(a) transmitting a non-scanning beam that illuminates the terrain and/or obstacles;

(b) receiving a Doppler shifted signal that is Doppler shifted by an amount dependent on an angle between a line of flight of the aircraft and scatterers that reflect the transmitted beam;

(c) determining the angle of an object or terrain cell nearest to the line of flight at a certain range; and

(d) displaying a distorted contour in the form of a half circle around the line of flight, whose radius represents the angular distance of this object from the line of flight.

42. (Original) A method according to claim 41 and including displaying a number of distorted contours for a number of ranges, along with a number of safety circles for corresponding ranges.

43. (Original) A method according to claim 41 and including making a coarse determination of azimuth, providing rough azimuth of large objects.

44. (Previously Presented) A method according to claim 41 and including determining the horizontal orientation of wires at low elevation, the method comprising:

determining azimuth of wire's reflection point; and

estimating the horizontal orientation as the normal to the determined azimuth.

45. (Withdrawn) A method according to claim 1, wherein said receiving a Doppler shifted signal includes receiving:

interlacing pulses having different attributes of frequency, antenna connection, beam position or polarization; and

utilizing the Doppler shifts of reflections of the interlaced pulses to perform spectral analysis of the reflections at different attributes, in parallel.

46. (Withdrawn) A method according to claim 45, including:

detecting suspended wires, based on normal impingement of said beam; and

determining the presence of the wire by:

irradiating the wire with radiation at two orthogonal polarizations; and

determining the presence of the wire from a ratio of received backscatter intensities in the two polarizations.

47. (Withdrawn) A method according to claim 46 and including determining the horizontal orientation or wires at low elevation, the method comprising:

determining azimuth of wire's reflection point; and

estimating the horizontal orientation as the normal to the determined azimuth.

48. (Withdrawn) A method according to claim 45 wherein the spectral analysis comprises FFT.

49. (Withdrawn) A method according to claim 45 wherein the attributes comprise frequency.

50. (Withdrawn) A method according to claim 45 wherein the attributes comprise polarization.

51. (Withdrawn) A method according to claim 45 wherein the attributes comprise antenna connection.

52. (Withdrawn) A method according to claim 45 wherein the attributes comprise beam position.

53. (Currently Amended) Radar apparatus for terrain mapping and/or obstacle detection for aircraft, comprising:

a transceiver that is ~~operative~~ constrained to emit a non scanning antenna beam and to receive signals reflected from said terrain and obstacles; and

a processor that includes:

a Doppler signal analyzer that receives said signals and determines an angle between scatterers associated with the signal and ~~a~~ the line of flight of the aircraft from the Doppler frequency;

direction finding that determines one of azimuth and elevation of the scatterers; and

a computer that computes the other of the azimuth and elevation from the determined azimuth or elevation and the determined angle.

54. (Original) Radar apparatus according to claim 53, comprising a monopulse antenna which has a steerable null, common to both sum and difference lobes.

55. (Withdrawn)

A method according to claim 1, wherein said determining the angle from the Doppler frequency comprises:

determining a roll angle of the aircraft; and

rotating transmitted polarized radiation to compensate for the roll angle of the aircraft.

56. (Withdrawn)

A method according to claim 1, comprising

determining a line of flight of an aircraft; and

detecting wires over an angle of over $\pm 70^0$ in azimuth about the line of flight.

57. (Withdrawn) A method according to claim 56 wherein said angle is equal to or below $\pm 90^0$.

58. (Withdrawn) A method according to claim 56 wherein said angle is above $\pm 90^0$.

59. (Previously Presented) A method according to claim 1 wherein the non-scanning beam is pointed substantially along a direction of flight of the aircraft.

60. (Previously Presented) A method according to claim 1 wherein the non-scanning beam is electronically steerable only in a single plane.

61. (Currently Amended) A method according to claim 60 wherein the single plane is a substantially horizontal plane when the ~~plane~~ aircraft ~~is in a straight and level flight~~ has substantially a zero roll angle.

62. (Currently Amended) A method according to claim 41 wherein the non-scanning beam is pointed substantially along a back to front axis of the ~~of the~~ aircraft.

63. (Previously Presented) A method according to claim 41 wherein the non-scanning beam is electronically steerable only in a single plane.

64. (Currently Amended) A method according to claim 63 wherein the single plane is a substantially horizontal plane when the ~~plane~~ aircraft ~~is in straight and level flight~~ has substantially a zero roll angle.

65. (Currently Amended) ~~A method~~Apparatus according to claim 53 wherein the non-scanning beam is pointed substantially along a back to front axis of the aircraft.

66. (Currently Amended) ~~A method~~Apparatus according to claim 53 wherein the non-scanning beam is electronically steerable only in a single plane.

67. (Currently Amended) ~~A method~~Apparatus according to claim 66 wherein the single plane is a substantially horizontal plane when the ~~plane~~ aircraft ~~is in straight and level flight~~ has substantially a zero roll angle.

68. (New) A method of terrain mapping and/or obstacle detection for aircraft, comprising:

(a) transmitting a beam which is either fixed or steerable in one axis and illuminates the terrain and/or obstacles;

(b) receiving a Doppler shifted signal that is Doppler frequency shifted by an amount dependent on an angle between ~~a~~ the line of flight of the aircraft and scatterers that reflect the transmitted beam;

(c) determining the angle from the Doppler frequency;

(d) determining the range of at least some of said scatterers; and

(e) determining the azimuth and elevation of the scatterers.

69. (New) A method according to claim 68 wherein the beam is transmitted and received via a same antenna.

70. (New) A method according to claim 1 wherein the beam is transmitted and received via a same antenna.

71. (New) A method according to claim 43 wherein the beam is transmitted and received via a same antenna.

72. (New) Radar apparatus according to claim 53 wherein the beam is transmitted and received via a same antenna.